# DETECTION OF A POSSIBLE SECONDARY NUCLEUS ORBITING THE PRIMARY OF COMET HALE-BOPP (C/1995 01)

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This paper reports the detection of an apparent satellite around the primary nucleus of this comet. Overlapping jet activity from such a comet pair might explain the exceptionally complex morphology of the dust coma. The detection was made by applying the deconvolution technique described by Sekanina (1995) to images taken with the Hubble Space Telescope's (HST) WFPC-2 in the PC-mode (0.0455 arcsec/pixel) on five days between 20 May and 23 October 1996. In each case the satellite showed up as a prominent clump of excess-signal pixels in the distribution of brightness residuals from a solution that assumed one point source (the primary) and one extended source (the surrounding coma). The companion's derived separation dist antes from the central body range from . 0.06 to 0.10 arcsec, corresponding to projected linear distances of 160 to 210 km. The satellite has not been detected on an image from 23 October 1995", probably because of its subpixel separation from the primary. On all but one observation clay in 1996, the effective diameter of the companion is found to be ~35 km (assuming a 4 percent albedo), almost exactly one half the diameter of the primary, their intensity ratio is between 0.16 and 0.28, implying a crude estimate of ~0.1 for their mass ratio. With its diameter of ~70 km (again for an albedo of 4 percent; Sekanina 1998), the primary's equatorial speed of rotation is 5.4 m/s (for a rotation period of 11.35 hours), its estimated mass is $(3.6 - 9.0) \times 10^{19}$ g for the range of assumed densities of 0.2–0.5 g/cm$^3$, the velocity of escape is 11 .7–18.6 m/s at the surface, but only 4.4–6.9 m/s 250 km away, and the corresponding radius of the primary's gravitational sphere of action is 380-550 km at perihelion, increasing linearly with heliocentric distance; the satellite would be in a stable orbit. On the other hand, with Weaver et al.'s (1997) lower estimate of 27 km for the nucleus diameter, it can be shown that the satellite's orbit would rapidly become unstable near perihelion and subsequently the secondary would widely be seen to drift away from the primary, contrary to observational evidence. Since a companion's orbit gravitationally bound to the primary is the more likely the more massive the central nucleus, ground-based observations of massive split comets are unlikely. The expected orbital period of the Hale-Bopp satellite at an average distance of -180 km from the primary would typically be ~3 days for a 70 km primary, but 9-14 days for a 27 km primary. In either case, the expected orbital period is substantially shorter than the 1-2 month intervals between the HST observations. Efforts aimed at calculating the orbit of the presumed satellite, and thus at determining the total mass of the system, will be underway very shortly.